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A Model for Improving Student Completion Rates in the TUD based on Competency Based Learning modules that improve ACRES and TAASOLC

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1. Introduction

Acronyms can be useful sometimes. Let's mint a new one, TAASOLC, see Fig 1. Next describe what TAASOLC means and tell a thread of a story. Continue by describe a solution with a list of quantifiable action items, based on community engagement models, for solving an education problem and a community development problem. The problem is increasing the number of students successfully completing a third level institute and (this conjunction is essential) at the same time gradually improving standards. The best way of getting the community engaged with a college, and a new 21st century Irish university, is to increase the number of success stories of all graduates, especially local ones, and to provide a pathway to lifelong employment and well as lifelong learning while doing what it can to eliminate poverty in the communities around the constituent campuses of the TUD.

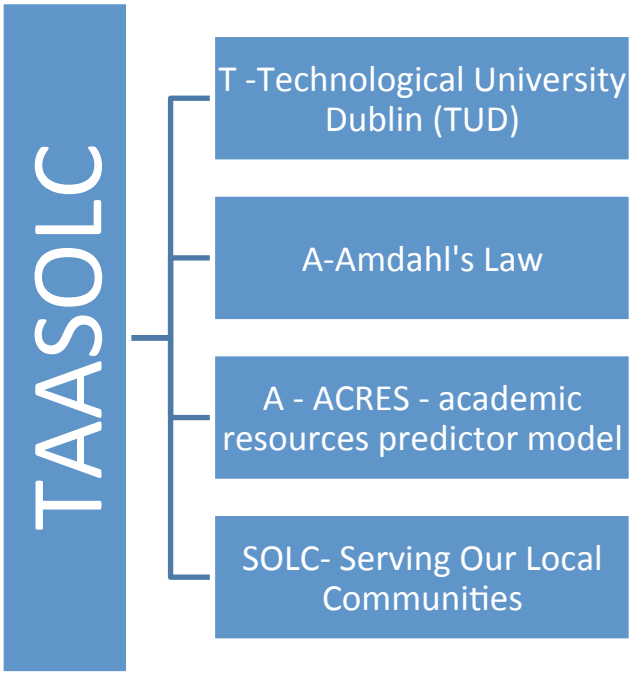

Figure 1: TAASOLC

2. T is for TUD in TAASOLC

The term TUD, Technological University for Dublin, refers to the merger of the three institutes Dublin Institute of Technology, IT Blanchardstown and IT Tallaght. Currently this is being driven by the General Scheme Technological Universities Bill (An Roinn Oideachais agus Scileanna (Department of Education and Skills), 2014).

At the time of writing this bill removes the name Blanchardstown and Tallaght from the legal Oireachtas documents defining the higher educational landscape. The removal of the names

Blanchardstown and Tallaght for the Oireachtas legal name is hopefully an oversight that will be rectified, as it is not a good start the further building of engagement with these communities. The interim name, for TUD, from sometime around May 2015 is DIT (this is what the bill states) and the name we should all be working for is TUD (or equivalent), the new university. The working overall interim name can be called DIT, but the bill must be modified to state that the new DIT shall consist of the DIT Tallaght Campus, the DIT Blanchardstown Campus and the DIT Grangegorman campus. The overall final name can be called TUD (or some equivalent), but the Bill must be modified to explicitly state the following "The Technological University of Dublin consists of the colleges TUD Blanchardstown Campus (formerly IT Blanchardstown), TUD Grangegorman and the any another former DIT sites (name them), and TUD Tallaght Campus (formerly called IT Tallaght). The TUD shall be considered a merger of equals serving in particular the communities of Tallaght and South Dublin County, Grangegorman and Central Dublin and Blanchardstown and Fingal County, as well as welcoming students from all parts of Ireland and the world, serving the greater Dublin region and the while of Ireland."

The other driver for the merger is the website www.tu4dublin.ie. The website contains many positive ideas, the invitation to be disruptive in a constructive way, to use of the term entrepreneurial university as outlines by Burton Clarke, (Clarke, 1998), a reimagined curriculum, the merged postgraduate school, and the improved international profile. However, as yet, it omits a detailed plan for how to tackle the poverty trap that exists in areas around all the three constituent campuses of TUD. Also there is no cogent explanation, yet, as to why the names of Tallaght and Blanchardstown are being dropped in the new legislation. Furthermore there is no interaction, as of yet, with the local communities in Tallaght to explain what benefits will accrue. There is also little evidence of a significant dialogue between the academic union, a key stakeholder representing most of the academic staff, and management which can be a very positive if nettles are grasped by both sides.

Burton Clarke's *Creating Entrepreneurial Universities* studied the transformation of the universities at Warwick (England), Twente (the Netherlands), Strathclyde (Scotland), Chalmers (Gothenburg, Sweden) and Joensuu (Northern Karelia, Finland). Clarke does not use the word 'entrepreneurial' in a narrow purely individualistic and socially devise ultra-capitalist sense, and

> *"instead of using the word '"entrepreneurial" over "innovative" as the organising conception this this book because it points more powerfully to deliberate **local effort**, to actions that lead to change in organisational posture*."

He goes on to say

> "*Universities are too bottom- heavy, too resistant from the bottom up, for tycoons to dominate very long. Rather, transformation occurs when a number of individuals come together in university basic units and across a university over a number of years to change, by means of organized initiative, how the institution is structured and oriented. Collective entrepreneurial action at these levels is at the heart of the transformation phenomenon. Acting from on high, national and state systems of higher education are blunt instruments of significant change; acting from below, individual faculty members or administrators are limited in what they can do.*

Reflecting on "*acting from on high*", how can the perception that the TUD project gathered legs in the middle of a recession and is not merely part of a government cost cutting process, with an associated organisational merry-go- round, be countered? I believe that creative synergies should take place at any time, and recessionary time is a great time for careful long term planning for an upside. However in the post Celtic tiger era where many hard decisions were necessary and unavoidable, is it wise to accelerate a merger until all doubts that this is not the case are held by a clear majority of stakeholders, not just those whose job it is to seek valid financial optimisations? Aside from any consideration of areas where costs can validly be cut, scaling up can be good provided local identity and service is jealously guarded. We need to continue to service our local communities AND create a new entrepreneurial synergy. The TUD team have convinced many, but many more remain, in my opinion, underwhelmed. An ethical sales job is in order, and you cannot do that with trade unions and

local community groups being held, for now and for whatever reason, at relative arm's-length. Clarke further reflects

> *"But groups, large and small - central and departmental - of faculty and administrators (and sometimes students!) can fashion new structures, processes, and orientations whereby a university becomes biased toward adaptive change*" .

I think what he is saying is that good systems emerge if people are left do their job with minimal managerialism and a sometime damaging Irish centralist mentality, provided clear overall goals and boundaries are set.

Does an Irish landscape allow such a transformation? Yes, provided all stakeholder, and this includes trade unions and local communities, get a decent look in before any final decisions are set in stone by government or anyone else. Properly implemented the TUD can change things for the better for the many. If it lacks the conviction to dream big dreams and the determination to solve a specific big problem that is tractable, it will be disappointing. The big problem is, like many other countries, too many students arrive on campus with a small probability of success, they are not all from a disadvantaged background but many are, and not enough students arrive from certain catchment schools. Not focusing on this problem misses a great opportunity for a dynamic TUD to fix it. The new TUD will not attract a high cohort of above 400 points students. Yes some courses will attract high points, but most applicants will have be in the 100 – 300 points region. The average of non-portfolio points for all course in all three institutes in 2014 was between 200 and 300 points. A reason for a new University is to make education more universal. In Ireland we have got knotted up in a point's race with many colleges and universities playing silly games with place allocation to boost points in order to give the totally false impression that high points are the only definitive positive thing that can be said about a course. On August 17th 2014, the *Irish Times* reported

> "*More than one-third of courses being offered by universities and institutes of technology have 15 or fewer places, and some 24 courses have only one place, in a pattern linked to the **"artificial inflation**" of college entry points*."
> (Humphreys, Colleges criticised over points 'inflation' ahead of CAO offers, 2014))

I am proud to work in an Institute that tries to reach out to all people in the community, those on high and low points and mature applicants, and has taken up, with great success, the challenge of transforming many lower point students into excellent graduates. It must be stated that, in spite of very many success stories, for many the low LC points often remains a challenge, and later on a newer solution is proposed to improve things even more. The wide spread of entry points must not allow anyone to ever drop standards anywhere. Until the effects of positive interventions are felt, some of which are in place, some failure rates in the more difficult course where entry points are low, will remain high and if they suddenly improve questions need to be asked.
A new 21st century Irish university should make education more universal to its local communities, educate for jobs in Ireland, and educate for the sake of knowledge and social capital in itself. Doing this will require structural change in the way points are awarded in the leaving certificate for robustly assessed preparatory work done alongside and outside the standard curriculum. The TUD must be a transformative merger of equals that represents their local communities and synergises into something that leads many in Dublin and all over the country out of poverty. Poverty exists in Ireland, despite an improving economic outlook. Time to aim high and deliver. I am confident that the staff of the three institutes and their communities basically wants this. TUD being a mere cost cutting exercise is anathema, I think it will be more than that but people have to stand up, be counted, and ensure a positive outcome. It is time to articulate how the positive outcomes are possible; this is the aim of this paper.

3. A is for Amdahl's Law in TAASOLC

Gene Amdahl is the computer architect behind the IBM360 that was announced in 1964. Amdahl specified a quantitative rule called Amdahl's law. This eponymous law finds the maximum expected

improvement to an overall system, (many systems not just a computer, even an educational system), when only a fraction (a certain part) of the system is focused on for improvement. Hennessy and Patterson (Hennessy & Patterson, 2012) apply the Law to speeding up the execution time of a computer and describe it as follows:

$$Speedup_{overall} = \frac{1}{(1 - Fraction_{ehanced}) + \frac{Fraction_{enhanced}}{Speedup_{enhanced}}}$$

We will now use different names of these things,

$$G = \frac{1}{(1-f) + \frac{f}{S}}$$

where *G* is the global improvement in the system due to an improved specific solution *S* applied for a fraction of the process *f*. The speedup factor S can also be regarded as positive intervention.

Worked Example: A computer spends 20% of its time executing instructions accessing memory and the remaining 40% of the time accessing peripherals. A new processor that has a speed improvement of ten times is used, what is the overall speedup?

$$f = 0.2, \qquad S = 10$$

$$G = \frac{1}{(1-f) + \frac{f}{S}} = \frac{1}{(1-0.2) + \frac{0.2}{10}} = \frac{1}{0.8 + 0.1} = \frac{1}{0.81} = 1.558$$

So we have a 56% percent improvement from something which could have improved things by a factor of 10, if it were applicable to all the time of the process. Hennessey and Patterson note

> '*Amdahl's Law expresses the law of diminishing returns ... Amdahl's Law can serve as a guide to how much an enhancement can improve performance and how to distribute resources to improve cost-performance*.'

A computer package called Desmos can be used to create a slider interface, where you can see what effect all this has on the value of CE. Desmos is an HTML 5 web application and the model can be tinkered with. You can experiment with the dynamics of Amdahl's Law by using the Desmos program Amdahl's Law (Stockil, Amdahl's Law DESMOS demonstration., 2014) , see Figure 2.

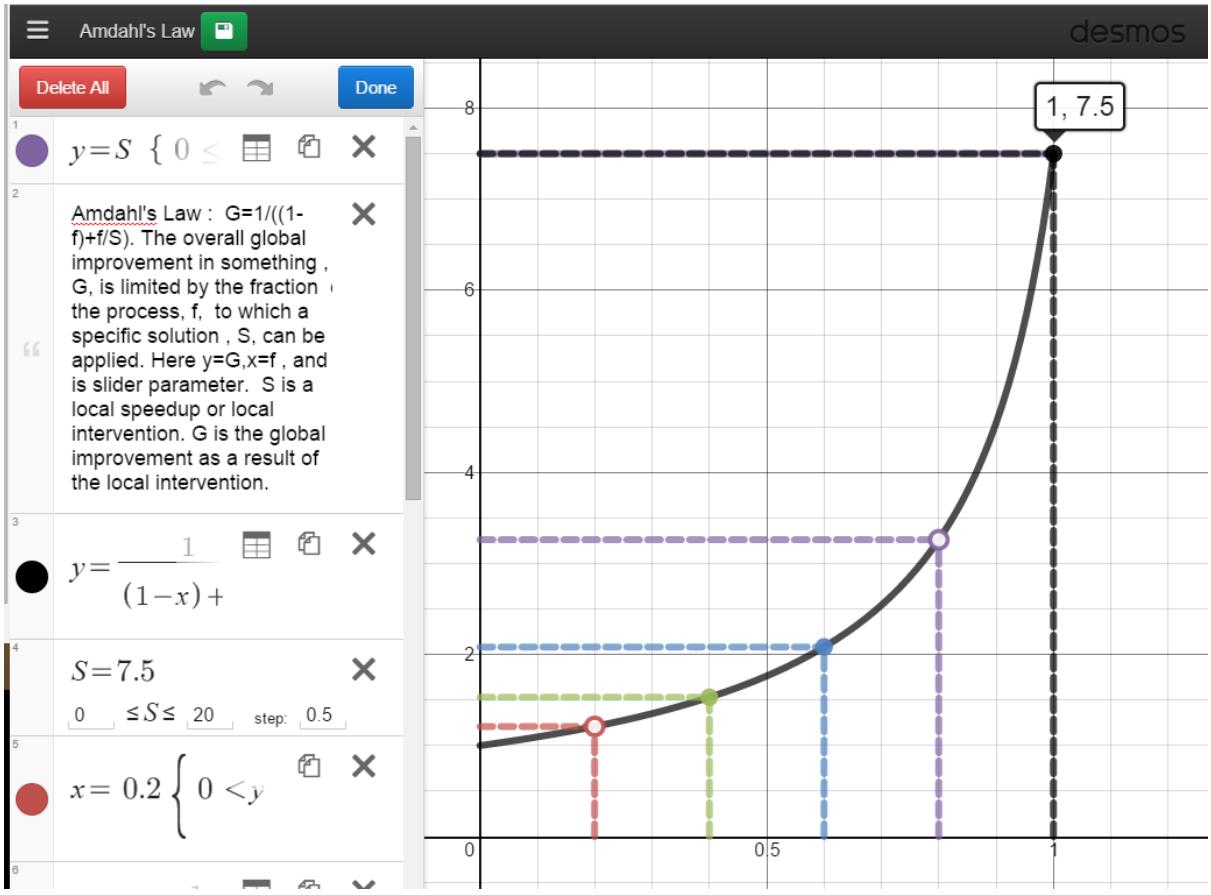

Figure 2: Amdahl's Law. Click here

4. A is for ACRES – academic resources – in TAASOLC

Clifford Adelman, (Adelman P. , 2006) a senior researcher at the U.S. Department of Education reflects on the National Educational Longitudinal Study 1988 which tracked the progress of over 12,000 of students from 1988 when they were aged around 14 (in 8th Grade) to 2000 when they were aged around 26. Combine the numbers 88 and 2000 with the acronym NELS and you get the name of the study NELS: 88-2000. One of his conclusions is

> "*The core question is not about basic "access" to higher education. It is not about persistence to the second term or the second year following postsecondary entry. It is about completion of academic credentials—the culmination of opportunity, guidance, choice, effort, and commitment.*"

The study details the numbers who did not enter third level education and those who did. Of those who did some completed course and some did not. What is impressive about the study beside its scale, is that one of its predictive parameters called ACRES, academic resources, acts as a predictor of success. The general finding was 66% completed a course, but there were wide differentials by socioeconomic status and by race/ethnicity. ACRES stands for ACademic RESources. It is a quintile index (it maps a student to one of five 20% ranges). It is based on a composite average of class rank, GPA (Grade Point Average) Score, and final senior year tests. ACRES in an Irish context is roughly the amount of points in the leaving certificate acted as the prime predictor of success. It was the major predictor of successful completion of a college course. Adelman discusses this and a later longitudinal study which gave similar results. In the summary he states,

> "*Two national longitudinal studies, a decade apart, have told similar stories. When the second story reinforces the first—and sheds even more light—something has to be right, and it behoves us to pay attention. Both of them provide support for current efforts to improve the*

quality of high school curricula and the participation in those curricula of ever larger proportions of students. Both of them provide guidance for college and community college processes likely to lead students to degree completion."

In their study of what determine degree completion rates among socioeconomically disadvantages students Cabrera and Burkum summarise many key finding in Fig 4, (Cabrera & Burkum, Pathways to a Four-Year Degree: Determinants of transfer & degree completion among socioeconomically disadvantaged students, 2005). A web version of the study is also available (Cabrera & Burkum, Pathways to a Four-Year Degree: Determinants of transfer & degree completion among socioeconomically disadvantaged students., 2005). It shows that level of preparation at secondary schools is the primary indicator of success at third level.

In colleges in Ireland we state that the first year experience is important, it is, and we place support structures there. However apart from suggesting to students that they apply to a particular local third level college, which is worthwhile in itself and happens via open days and school visits, IOTs (and universities) play no significant role in improving the academic quality, ACRES, of student arriving at their doorstep. They should try to do so. If they do not then nothing significant will change. This is discussed in the following model, later some solutions are proposed which would allow this to happen.

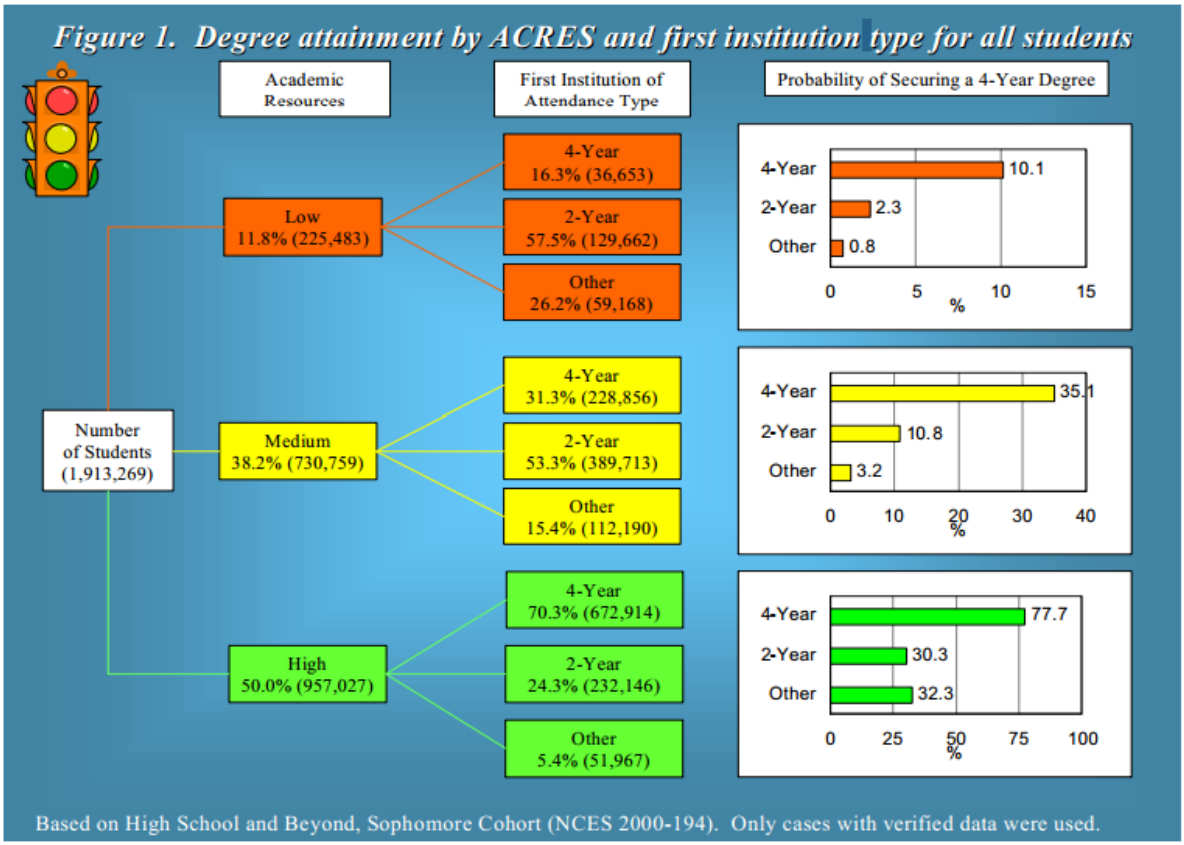

Figure 3: Academic Progression rates by students of different Academic Resource (ACRES), low (red), medium (yellow) and high (green). (Cabrera & Burkum, Pathways to a Four-Year Degree: Determinants of transfer & degree completion among socioeconomically disadvantaged students, 2005)

5. The College Effectiveness Metric

A college is measured by how many students complete a course subject to verifiable quality standards. Yes other things are measured as well but this is the primary measure. We will call this measure CE, **college effectiveness**, which is this simplified model, is a function of three things only:

1. a metric of what the student experience is before year 1, called BY1 (before year 1, call the variable B, where **B** stands for **before** year 1),
2. what the student experience is in year 1 (YR1, called the Y variable , **Y** stands for **year 1)**
3. what the student experience is after year 1 (AY1, call the variable A, where **A** stands for **after** year 1).

$$CE = f(BY1, YR1, AY1) = f(B, Y, A)$$

If the college effectiveness is determined by these three things, these three things all add to unity,

$$B + Y + A = 1$$

The measure of college effectiveness C_E

$$C_E = a \times B + b \times Y + c \times A$$
$$C_E = aB + bY + cA \quad \text{where } B + Y + A = 1$$

where C_E is the college effectiveness. The aim is to maximise this $C_E$number, the bigger this number the more students complete a course of study to a measurable quality standard. The parameters a, b, and c are specific speedup factors for the fractions B, Y and A. These speedup factors could also be described as intervention factors. The national longitudinal study in the U.S.A (NELS: 88-2000.) shows that the best predictor of success in college in the academic resources. Dropout rate is a problem mainly in year 1, so give what happens in year 1 a weighting of 0.4, this gives a weighting of 0.2 for what happens after year 1. The high weighting factor of 0.4 to what happens before year 1 is justified by the NELS:88-2000. Relating it to Amdahl's law it is the portion of the process that is not really optimised, yet it limits the throughput substantially. The Desmos College Effectiveness calculator (Stockil, College Effectiveness Calculator (Desmos), 2014) can be viewed by clicking here. This allows you to see the effects of different parameters in C_e, the college effectiveness.

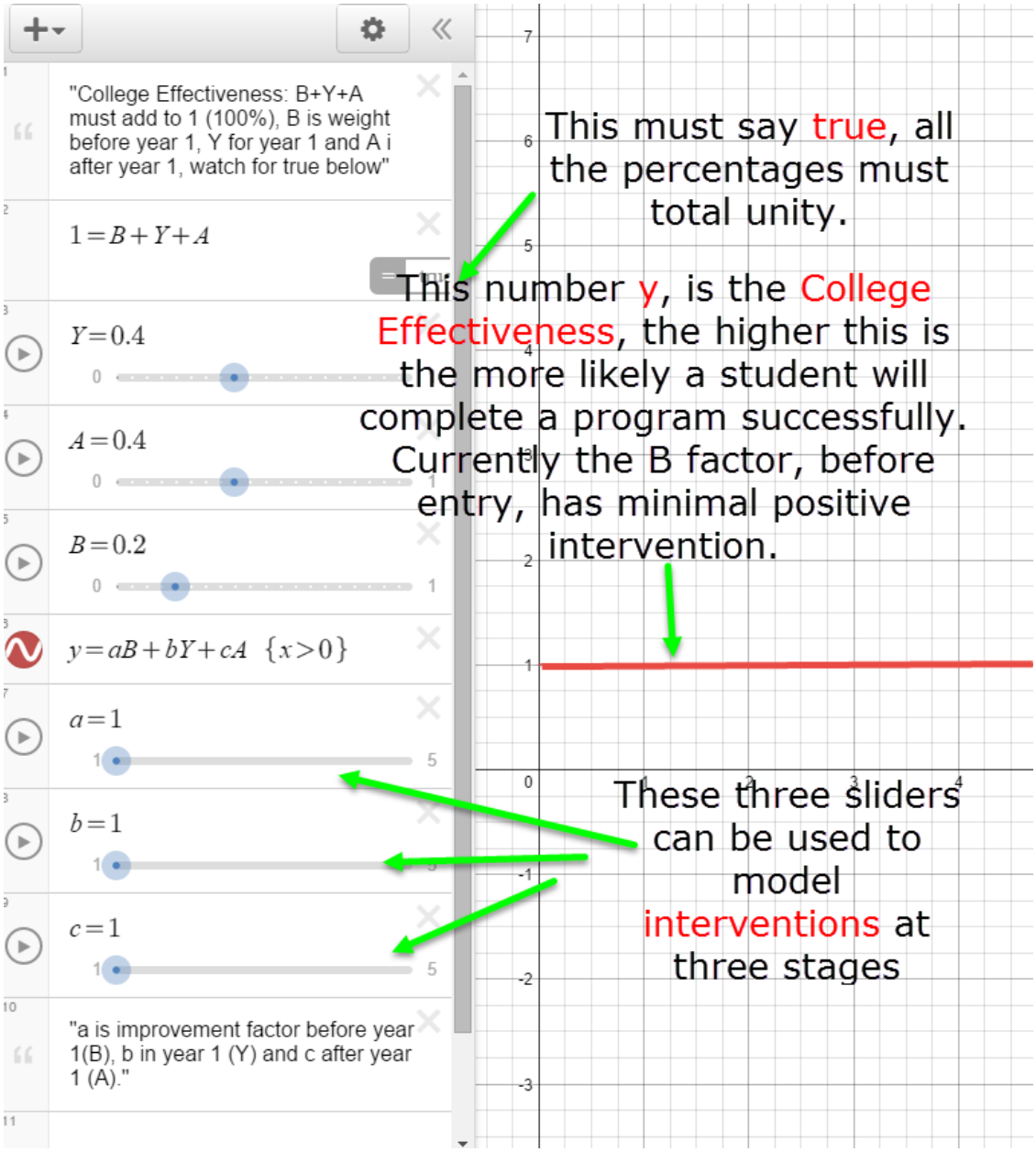

Figure 4: College Effectiveness Calculator, click here.

Figure 5 shows the results of different values of a, b and c which the fractions of Y, A and B are kept constant at 0.4, 0.4 and 0.2 respectively.

$$C_E = aB + bY + cA \quad \text{where } B + Y + A = 1$$

B =0.4, Y=0.4 and A=0.2

CE is college effectiveness, maximise this.

Scenario	a	b	c	CE	Commentary, for leaving cert points think ACRES to obtain better predictor.
1	1	1	1	1	A college with very low points and no first year intervention.
2	1	3	1	1.8	A college with very low points and very good first year intervention
3	2.4	1	1	1.56	A college with medium points and no first year intervention.
4	2.4	3	1	2.36	A college with medium points and a very good first year intervention
5	4	1	1	2.2	A college with high points and no first year intervention.
6	4	3	1	3	A college with high points and very good first year intervention
7	**1.6**	**3**	**1**	**2.04**	A college with alternative preparation streams before year 1 and an very good first year intervention scheme

COLLEGE EFFECTIVENESS SCENARIOS

Figure 5: Results CE (College Effectiveness) Model

In these seven scenarios before first year has a weighting of 0.4, first year has a weighting of 0.4 and after first year has a weighting of 0.2. Scenarios 1 and 2 show low points entrants going to a college with no intervention scheme is year one and very good one. The weighting of 3 for the b factor assumes that the college has finely tuned its first year program. The weighting of 1 means that the college still does a professional job. A three to one improvement in anything is difficult to achieve. Scenarios two and three are similar to scenario 1 and 2 except the points are medium, and scenario 5 and 6 are also similar to 1 and 2 except the students are high achievers. Now consider scenario seven, and reimagine things a little. A college has implemented an augmented entry system, adding 60 **assessed** points to the documented learning experience of a secondary school student who on average get 100 points in the conventional leaving certificate system, this gives an a weight of 1.6 (effective point divided by one hundred). The college which did this offered on lines course so that everyone could join in but sent out SWAT teams made up of local secondary teachers and interested staff in the college to coach the students in schools with very poor college transfer rates. This was done patiently, with many setbacks, some serious, which were patiently addressed, over a ten year period and the college management did not flinch when setback occurred but continued their support. The Department of Education, which just before the established of TUD in 2016 overhauled the points system to improve access and completion, took a long-term view and supported in through thick and thin. The management knew it would work eventually because Amdahl's Law told them so. The funding for this was found form a combination of EU sources, industry sponsorship and the department of education. It transformed the life experiences of the students involved and released many from the poverty trap. As a result of improve academic profiles in areas where participation rates used to be lower, many companies invested in these areas and poverty was reduced dramatically.

6. SOLC is serving our local communities in TAASOLC

The Regional Technical Colleges Act, 1992 states

5. *The principal function of a college shall, subject to the provisions of this Act, be to provide vocational and technical education and training for the economic, technological,*

scientific, commercial, industrial, social and cultural development of the State with particular reference to the region served by the college,

I think that the colleges have generally fulfilled this role. I can think have numerous examples from my college, IT Tallaght, that have fulfilled the above and other colleges can point to many similar achievements. Without IT Tallaght even less citizens from the South Dublin region and this includes many disadvantaged citizens would go to college. However the big picture still worries me. Consider Figure 6, which shows the inequality of access in D24 and other regions (Humphreys, Some 99% of Dublin 6 students go on to third-level, 2014). Yes, we have made progress in some area but still have a deeply unequal Dublin (and Ireland) with pockets of extreme poverty around the campuses of the future DTU.

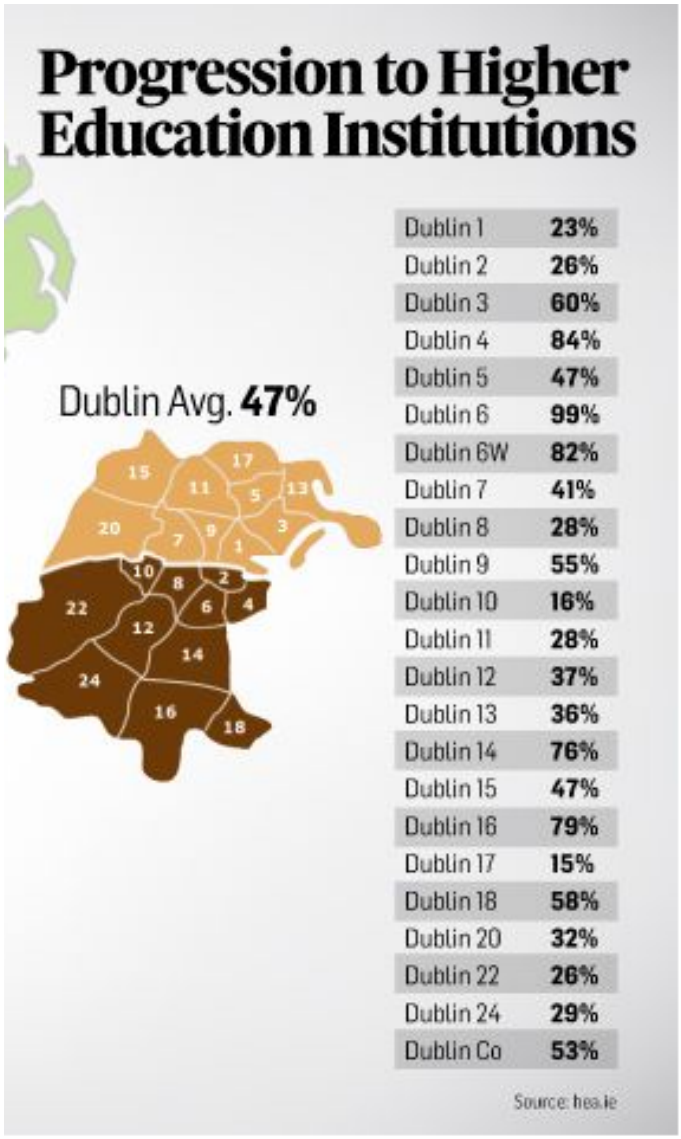

Figure 6: Inequality of Access, Source: Irish Times.

Why is there still such inequality of access? The merger should be seen as a merger of communities, communities that have to be served, SOLC – serving our local communities. If TUD can do that better great, but the focus has to be on constituent campuses serving their local communities as the primary aim, and the superposition and synergy of these three campus giving a bigger advantage to the greater Dublin region and the country. The poverty traps in certain parts of Dublin correlate highly to the figures for third level access - look at Figure 6. Now consider Figure 7, which shows the

number of students and staff at the constituent campuses of the DTU as well as the populations of three local authorities in which the constituent campuses find themselves.

	Students			Staff			Region		
Blanchardstown	3023	13%		210	9%		Fingal	273991	26%
DIT	16208	69%		1888	78%		DCC	527612	49%
Tallaght	4401	19%		335	14%		SDCC	265205	25%
Total	23632	100%		2433	100%		3 Regions	1066808	100%
UCD	23499						DLRathdown	202261	
Trinity	16541								
DCU	11164								

Figure 7: The Merger in Numbers: Buildings, Power Structures or Communities?

7. How to Do It - Competency Based Learning Modules that augment the Leaving Certificate

The following is an outline plan:

- Identify the schools that do not contribute enough students.
- Offer on-line courses for students in year one to six at all secondary schools in the following subject areas (or similar),
  1. Grammar and written English.
  2. Robotics and 3D Printing.
  3. Maths using Desmos
  4. Introduction to Local History and Heritage
  5. Philosophy
  6. Irish
  7. The Science and Art of Good Health
  8. Science Applications.
  9. Computer Programming
  10. Creative Writing

- Fund a SWAT team consisting of many dedicated secondary schools teachers and staff and students from TUD to support the most disadvantages schools.
- Work with local and worldwide content creators and leverage Creative Commons work to design these, and similar, modules
- These modules are on line and studied after schools hours, link the study to sports and recreation events as well and build up social capital by involving parents.
- The exam must be of a high standard, it must "hurt" to complete it but in an enjoyable way. If you pass the exam with different grades you get up to 40 leaving cert points per module. Take six modules and you could get an additional 240 points. Many students will never take six but even if one is done, and done well it can have a very positive effect.
- If the response of the TUD is to embrace such a system it will do what it is supposed to do, serve local communities and eradicate poverty as much as possible?

If the response is it is not really our job, that is the domain of secondary school and the department of education alone, then it will have missed a golden opportunity and twenty years from now similar levels of disadvantage and poverty will still exist in many areas surrounding the three communities that are to be served (see Figure 7), and the TUD will have been a cost cutting exercise that maybe get a few more less important things right but has not really done its job. There is a large literature that

describes these courses and initiatives. Space limits a detailed discussion. One website that discussed competency based learning at secondary and third level is from the US Department of Education. (Estrada, 2014). Competency based learning is stressed in Post Secondary section of the Gates Foundation, see http://postsecondary.gatesfoundation.org/. Their banner theme is

> "*Too few U.S. students are ready for college when they arrive, more than 40% drop out before finishing*".

Let's be honest, despite some excellent results, in too many courses all over Ireland the same can be said. Finally, Golston describes a model for postsecondary success using predictive data analytics, next generation courseware and evidence based approaches to improve student success. (Golston, 2014)

8. Summary

The TAASOLC (Technical University of Dublin, Amdahl's law and ACRES, serving our local communities) acronym was minted. Some of the issues of TUD have been discussed, the many positive things have been acknowledged and questions have been raised about things that can be fixed. A model of college success, called college effectiveness, CE, based on Amdahl's Law and the largest ever survey of why certain groups go to college has been presented. The importance of the new TUD serving our local communities and paying attention to the deep inequality in access that still exists in our system is stressed.

A model for improving access based on supplemental modules offered in the secondary school cycle is presented, such a development would leverage from work in competency based learning and learning data analytics, and if tried and patiently optimised will succeed because of Amdahl's Law. It may be an exciting time to be involved in education, if the TUD grasps the nettle and attacks the problem of disadvantage using solutions similar to the ones proposed in this paper; or any other solutions that work. It can use its size to force this issue against those who think things are just fine as they are, and that it acceptable to allow poverty traps and serious access disparities to continue to flourish in twenty first century Ireland. It can do this if it really wants to, if it really wants to be a new university, and I remain confident that it will. Time will tell.

References

Adelman, C. (2006). *THE TOOLBOX REVISITED, THE TOOLBOX REVISITED*. Retrieved Nov 24, 2014 from https://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf

Adelman, P. (2006). *THE TOOLBOX REVISITED, Paths to Degree Completion From High School Through College*. Retrieved Nov 24, 2014 from https://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf

An Phríomh-OifigStaidrimh(CSO). (2013). *Regional Quality of Life in Ireland 2013*. Dublin: Central Statistics Office Ireand - An Phríomh-OifigStaidrimh.

An Roinn Oideachais agus Scileanna (Department of Educatiuon and Skills). (2014). *General Scheme Technologica -Universities Bill 2014*. Retrieved November 21, 2014 from https://www.education.ie/en/The-Education-System/Legislation/General-Scheme-Technological-Universities-Bill-2014.pdf

Cabrera, A., & Burkum, K. (2005). *Pathways to a Four-Year Degree: Determinants of transfer & degree completion among socioeconomically disadvantaged students* . Retrieved November 24, 2015 from http://www.inpathways.net/Pathways_determinants.pdf

Cabrera, A., & Burkum, K. (2005). Pathways to a Four-Year Degree: Determinants of transfer & degree completion among socioeconomically disadvantaged students. In

College Student Retention: Formula for Student Success. (American Council on Education/Oryx Press Series on Higher Education).
Clarke, B. (1998). *ENTREPRENEURIAL PATHWAYS OF UNIVERSITY*. Retrieved November 23, 2014 from http://www.oktemvardar.com/docs/BRC_entrepreneurial.pdf
Estrada, E. (2014). *Engineering Education: The U.S. Department of Education Releases Innovative Initiatives*. Retrieved Nov 23, 2014 from http://www.ed.gov/blog/2014/07/engineering-education-the-u-s-department-of-education-releases-innovative-initiatives/
Golston, A. (2014). *Examining Postsecondary Success and Challenges*. Retrieved Nov 2014, 2014 from http://www.impatientoptimists.org/Posts/2014/10/Examining-Postsecondary-Success-and-Challenges
Hennessy, J., & Patterson, D. (2012). Computer Architecture, Fifth Edition: A Quantitative Approach. Morgan Kaufmann.
Humphreys, J. (2014). *Colleges criticised over points 'inflation' ahead of CAO offers*. Retrieved Nov 23, 2014 from http://www.irishtimes.com/news/education/colleges-criticised-over-points-inflation-ahead-of-cao-offers-1.1899556
Humphreys, J. (2014). *Some 99% of Dublin 6 students go on to third-level*. Retrieved November 24, 2014 from http://www.irishtimes.com/news/education/some-99-of-dublin-6-students-go-on-to-third-level-1.1901885
Ní Chonaill , D., & Harris, D. (2014). Equality of access to higher education: discussion of emerging issues regarding the performance of migrants at the Institute of Technology Blanchardstown. *ITB Journal* (25), 83..88.
Stockil, G. (2014). *Amdahl's Law DESMOS demonstration.* Retrieved Nov 23, 2014 from https://www.desmos.com/calculator/b26je30p8r
Stockil, G. (2014). *College Effectiveness Calculator (Desmos)*. Retrieved Nov 22, 2014 from https://www.desmos.com/calculator/44rpi7deny